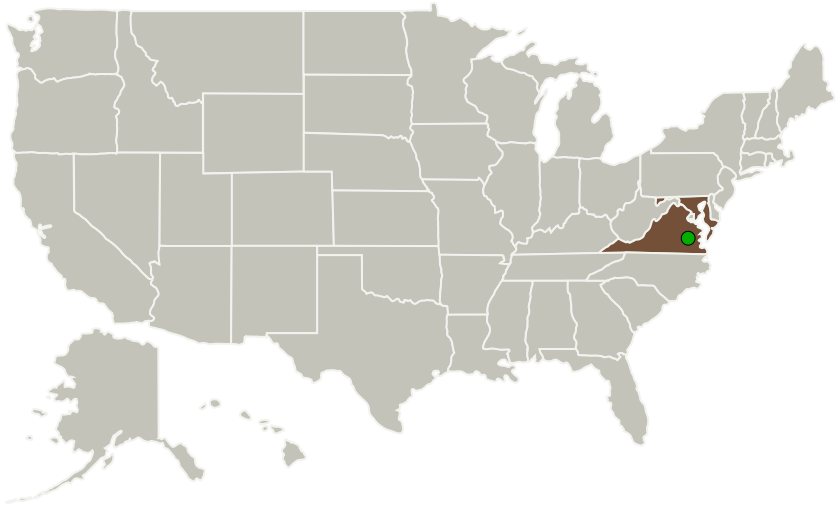
Verification and Validation of Adaptive Learning Control System Towards Safety Assurance and Trusted Autonomy, Phase I

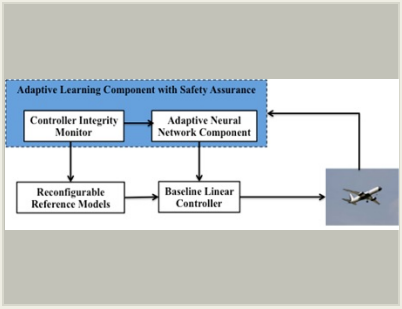
Completed Technology Project (2015 - 2015)

Project Introduction

In order to fulfill the present and future aerospace needs of the nation, there has been a growing interest in adaptive systems incorporating learning algorithms. Before such adaptive systems can be adopted for use in safety-critical aerospace applications, they must be certified to meet specified reliability and safety requirements. Intelligent Automation Inc. (IAI) in collaboration with Wright State University (WSU) proposes to develop a novel systematic verification and validation framework for adaptive learning flight control systems towards real-time safety assurance and trusted autonomy. A Neural Network (NN) based adaptive controller is designed as an add-on to a previously certified baseline linear controller to enhance robustness to modeling uncertainty and fault-tolerance to system faults. Based on Lyapunov stability theory, an integrity monitoring scheme for the adaptive controller will be developed to detect potential controller malfunctions and unstable learning conditions caused by unanticipated hazardous conditions. The proposed architecture can potentially maximize the use of advanced adaptive controller with high performance capabilities, while ensuring the safety of the overall flight control system in the presence of unanticipated hazards. In Phase I, the algorithms will be demonstrated using a real-time quadrotor test environment.

Primary U.S. Work Locations and Key Partners





The key innovation of this effort is to develop a novel systematic verification and validation framework for adaptive learning flight control systems, Phase I

Table of Contents

Verification and Validation of Adaptive Learning Control System Towards Safety Assurance and Trusted Autonomy, Phase I

Completed Technology Project (2015 - 2015)

Organizations Performing Work	Role	Type	Location
Intelligent Automation, Inc.	Lead Organization	Industry	Rockville, Maryland
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Maryland	Virginia

Project Transitions

June 2015: Project Start

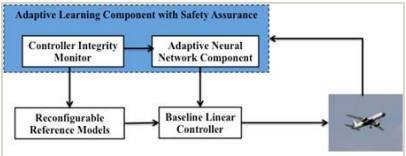
December 2015: Closed out

Closeout Summary: The key innovation of this effort is to develop a novel syst ematic verification and validation framework for adaptive learning flight control systems, Phase I Project Image

Closeout Documentation:

- Final Summary Chart Image*(https://techport.nasa.gov/file/139538)*

Images



Briefing Chart Image
The key innovation of this effort is to develop a novel systematic verification and validation framework for adaptive learning flight control systems, Phase I *(https://techport.nasa.gov/image/133103)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Intelligent Automation, Inc.

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

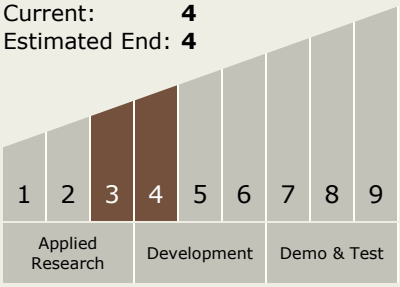
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Devendra Tolani

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Verification and Validation of Adaptive Learning Control System Towards Safety Assurance and Trusted Autonomy, Phase I

Completed Technology Project (2015 - 2015)

Technology Areas

Primary:

- TX10 Autonomous Systems
  - TX10.4 Engineering and Integrity
    - TX10.4.1 Verification and Validation of Autonomous Systems

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System